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Diffraction Enhanced Imaging of Stressed and Unstressed Bones

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Beamline(s): X15A

Introduction: Images of bovine cortical bones were obtained using Diffraction Enhanced Imaging (DEI) prior to and after being fatigue loaded. The images of the stressed and unstressed bones were then qualitatively compared to see if one could see small fractures in the bone. In addition to DEI, rocking curves were taken of the bones prior to and after being stressed. The rocking curves were then compared to see the effect of stressing the bone.

Methods and Materials: All images were acquired with 40 keV x-rays on a Fuji HR5 image plate read out using a Fuji BAS2500 Image Plate Reader. The experimental setup is described in reference 1. Diffraction enhanced images of the unstressed bovine cortical samples were acquired on either side of the rocking curve and then combined according to the DEI algorithm [2]. Rocking curves of the samples were measured by rocking the analyzer crystal about the rocking curve peak. The samples were then fatigue loaded until their strength was reduced by approximately 15 percent. They were then imaged, and rocking curves were measured again. The stressed and unstressed images were qualitatively compared, and the full-width half-maximum (FWHM) of the rocking curves were compared.

Results: Figure 1 shows the refraction images of the unstressed and stressed bone samples. Close inspection of the highlighted sections (A-D is the center of the figure) reveals that there are slight differences between the two images. This shows that there is a change in the bone due to fatigue loading the sample. The control bone, which was not fatigue loaded, was imaged with the stressed and unstressed bones and there was not a qualitative difference between the two images of the bone. The rocking curve comparison (Figure 2) shows a narrowing of the rocking curve due to the fatigue loading of the sample. The FWHM of the stressed rocking curve is 9% narrower than that of the unstressed rocking curve.

References: [1] Z. Zhong, W. Thomlinson, D. Chapman, D. Sayers, "Implementation of Diffraction Enhanced Imaging Experiments at the NSLS and APS," Nucl. Instr. And Meth. A **450** 556-567, 2000

[2] D. Chapman, W. Thomlinson, R.E. Johnston, D. Washburn, E. Pisano, N. Gmur, Z. Zhong, R. Menk, F. Arfelli, and D. Sayers, "Diffraction Enhanced X-ray Imaging," Phys. Med. Biol. **42** 2015-2025, 1997

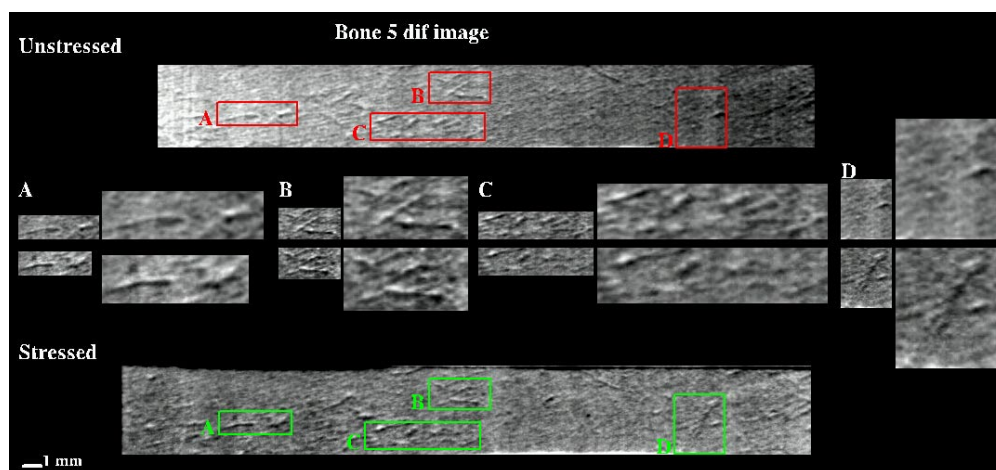


Figure 1- Comparison of Refraction Images of Unstressed and Stressed Bones. The larger image on the right is a magnified (2x) image of the smaller image on the left.

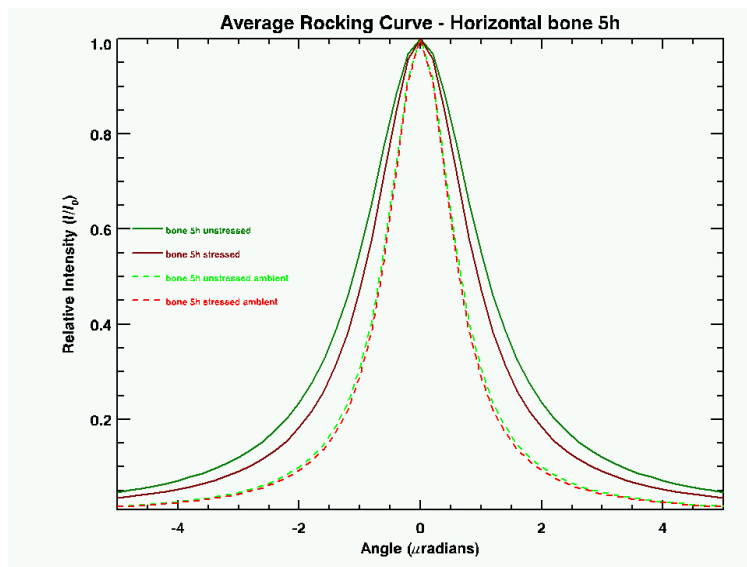


Figure 2- Comparison of Unstressed and Stressed Rocking Curves